Chatham Waterfront

Phase I Contaminated Land Risk Assessment

January 2011

Medway Council and A2 Dominion

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Issue and revision record

Document Reference: 251348/EVT/EES/01

Revision	Date	Originator	Checker	Approver	Description
A	05 January 2011	L Bethell	T Blower	A Campbell	First Issue

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Executive Summary

Medway Council and A2 Dominion are proposing to redevelop the Chatham Waterfront site, at Chatham, Kent. The development comprises a mixed use scheme including commercial/ retail and residential uses with buildings of up to eight storeys. At this stage, there are no proposed residential gardens. The river wall will also be improved as part of these works and any relevant flood mitigation measures will be implemented, including raising of site levels, where necessary.

Mott MacDonald was commissioned by Medway Renaissance and A2 Dominion to undertake a Phase I Contaminated Land Risk Assessment in order to identify risks to the project from land contamination, identify any actions that may be appropriate for the safe development of the site and to support the planning process requirements.

The site is underlain by superficial cover of made ground and alluvium, River Terrace / Head Deposits (varying across the site), overlying the Lewes Nodular Chalk Formation (formerly classified as Upper Chalk) part of the White Chalk Subgroup.

The site has been developed with a variety of industrial and commercial uses both on-site and in the vicinity, mainly comprising warehousing and wharf buildings associated with the River Medway. There is also evidence of some former residential land-use towards the southeastern end of the site. The river wall adjacent to the site has historically been further inland than the present alignment, with the present alignment not reached until the 1970s. This suggests that remnants of former underground structures may remain beneath the development area.

The principal contamination sources within the proposed development area relate to the existing site usage as car parking (and any potential fuel/ oil spillages/ losses) and historical uses for wharves (including the crane and tanks), warehouses, an ice factory and an electricity substation. In addition historical off-site uses of the Coal Yard, Timber Yards and Saw Mills could have been potentially contaminative.

The preliminary risk assessment, using desk study information and previous ground investigation data, concludes that there is a LOW risk to water resource receptors (groundwater in the underlying Secondary and Principal aquifers and the River Medway), a LOW risk to current and future site users, and a VERY LOW risk to construction workers, assuming appropriate PPE is used and good site hygiene practices are followed. No significant remediation works are likely to be necessary in the areas of the site investigated to date.

However, it should be noted that this assessment is based upon site investigation data from part of the site only and it cannot be guaranteed that this an accurate reflection of the ground conditions within the remainder of the Chatham Waterfront development area.

Therefore, it is recommended that additional intrusive site investigation and programme of environmental monitoring and laboratory testing is undertaken in the areas of the site that have not previously been investigated to more fully understand the subsurface conditions at the site as a whole and to confirm the findings of the initial ground investigation and conceptualised pollutant linkages highlighted in this report.

The site investigation should assess soil, groundwater and ground gas conditions and composition and the associated reporting should assess any risks to receptors (such as controlled waters, human health, and so on). It is recommended that these investigations are undertaken in conjunction with any Geotechnical Investigations which will be required to support the design process.

1. Introduction

1.1 Background

Medway Council and A2 Dominion are proposing to redevelop the Chatham Waterfront site, at Chatham, Kent. The development comprises a mixed use scheme including commercial/ retail and residential uses with buildings of up to eight storeys. At this stage, there are no proposed residential gardens. The river wall will also be improved as part of these works and any relevant flood mitigation measures will be implemented, including raising of site levels, where necessary.

Mott MacDonald was commissioned by Medway Renaissance and A2 Dominion to undertake a Phase I Contaminated Land Risk Assessment in order to identify risks to the project from land contamination, identify any actions that may be appropriate for the safe development of the site and to support the planning process requirements.

1.2 Scope of Work

The scope of works comprises a review of readily available environmental and historical information, including information from previous ground investigations; and a preliminary (Phase 1) contaminated land risk assessment prepared in accordance with current government and industry guidance.

1.3 Sources of Information

The information for this investigation has been taken from the following sources:

- Published geological and hydrogeological mapping;
- An Envirocheck Report supplied by Landmark Information Group (presented as Appendix A);
- A previous site reconnaissance visit; and
- Previous Ground Investigation Data.

1.4 Responsibility and Limitations of Information

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To the extent that this document is based on information obtained in previous ground investigations, persons using or relying on it should recognise that any such investigation can examine only a fraction of the subsurface conditions. In any ground investigation there remains a risk that pockets or “hot-spots” of contamination or other hazards may not be identified, because investigations are necessarily based on sampling at localised points. Certain indicators or evidence of hazardous substances or conditions may have been outside the portion of the subsurface investigated or monitored, and thus may not have been identified or their full significance appreciated.

2. Environmental Setting

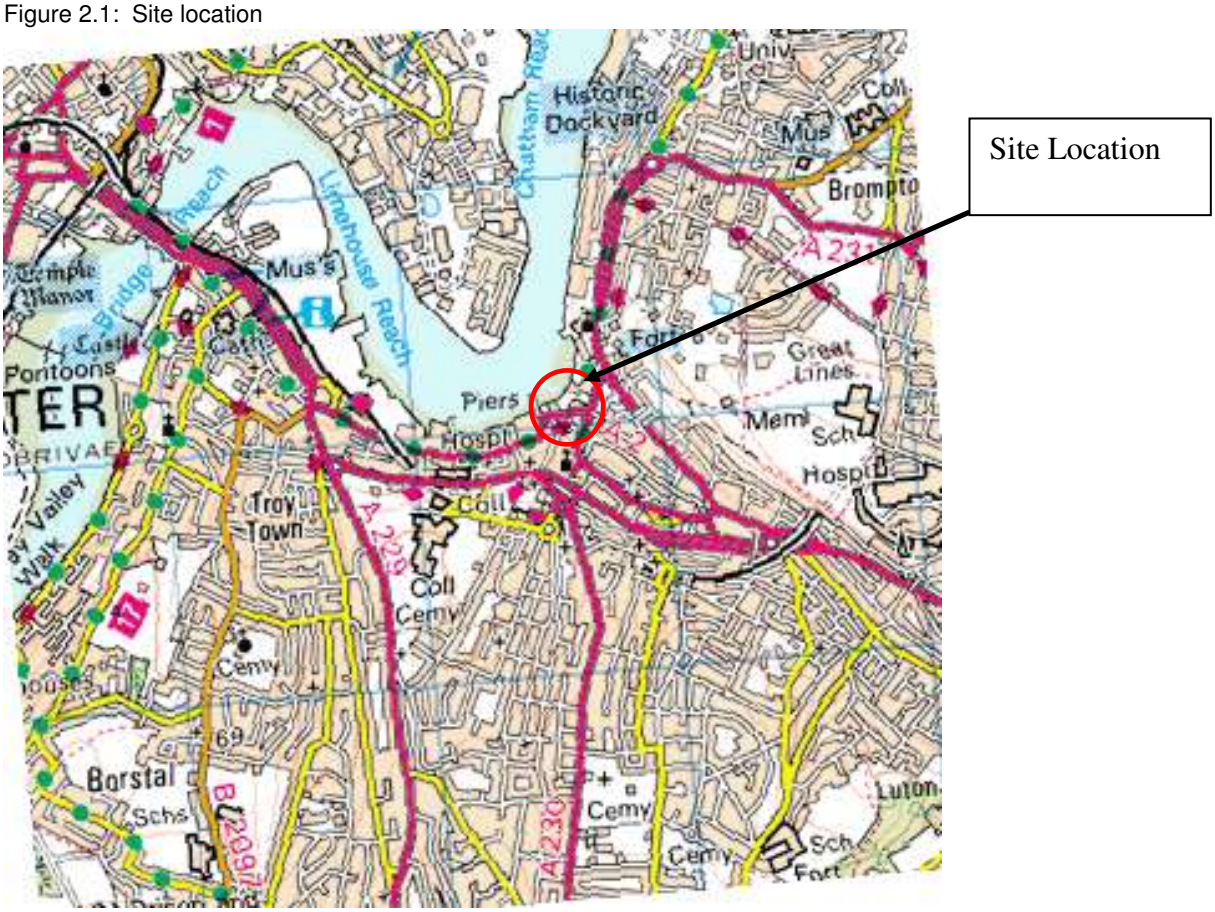
2.1 Introduction

The following Section outlines the environmental setting in terms of site surroundings, topography, geology, hydrogeology and hydrology.

2.2 Site Location and Description

The site under investigation is located on the southern bank of the River Medway, to the east of Sun Pier. The approximate National Grid Reference at the centre of the site is TQ 755 681. A site location plan is presented in Figure 2.1:

Figure 2.1: Site location



The site occupies an area of approximately 0.6ha and is irregular in shape. It is located at approximately 4.6m above Ordnance Datum (m AOD) and the area is generally flat lying. Sun Pier lies close to the apex of a sharp meander in the River Medway, which is tidal in this area.

The site largely comprises areas of car parking, with cafés offices and retail units along the southeastern boundary of the site, and a pumping station close to the northern corner of the site. The ground surface is a mixture of hard surfacing used for car parking, some of which shows evidence of former buildings that previously occupied the area, and an area of open ground which is grassed. A site layout plan is presented as Drawing number MMD-251348-EVT-DR-00-XX-0001 in Appendix B.

The overall development site is bordered by a sheet pile river wall to the north and Medway Street to the south. To the west is a warehouse and associated car parking currently occupied by Staples, with Sun Pier beyond. To the east is a snooker club and former Council Offices that have been demolished.

2.3 Geology and Hydrogeology

2.3.1 Geology

The published British Geological Survey 1:50,000 scale geological map Sheet 272 (BGS, 1977) and the BGS GeoIndex (BGS, 2010) were reviewed to determine the anticipated geological conditions in the vicinity of the site.

The published geological map clearly indicates that the site is underlain by Alluvium overlying the Lewes Nodular Chalk Formation (formerly classified as Upper Chalk) part of the White Chalk Subgroup.

However, remnants of other deposits, namely Head and River Terrace Deposits are present in numerous patches along the edges of the River Medway in this area. These materials lie underneath the Alluvium and rest on the Chalk. Although no such deposits are shown directly underlying this site, it remains a possibility that they may be present, albeit masked by the alluvium.

Due to the urban development history of this part of Chatham, it can be anticipated that these natural strata are overlain by a layer of made ground.

Based on the above information the expected geological sequence at the site is shown in Table 2.1 overleaf.

Table 2.1: Expected Site Geology

Geological Unit	Description	Estimated Thickness (m)
Made Ground	Variable	Not Known
Alluvium	Mainly sand, silt and clay	< 5
[Possible Head or River Terrace Deposits]	If present, likely to be granular, probably sands and gravels	<5
Lewes Nodular Chalk Formation	White variable chalk with flints	90+

2.4 Hydrogeology

Based on the Water Framework Directive (EU, 2000), the Environment Agency (EA) have classified three groundwater resource types (aquifers) as Principal Aquifers, Secondary Aquifers and Unproductive Strata based upon their importance as a resource (drinking water supply) and their support for surface water flows and wetland ecosystems. Principal Aquifers are considered to have the greatest capacity and unproductive strata the least. Secondary aquifers are divided into two types, A and B, based on their ability to store and yield groundwater.

The Environment Agency website (EA, 2010) indicates that the site is underlain by a Secondary (undifferentiated) aquifer, associated with the Superficial Deposits. The underlying Chalk is classified as a Principal Aquifer and as the Superficial Deposits and Chalk are likely to be in hydraulic continuity the site is considered to be located over a Principal Aquifer.

Based on the topography and hydrology of the area, the expected regional groundwater flow direction is northwards towards the River Medway. However, the situation at the site itself may be more complex and variable due to the tidal nature of the River Medway.

The site does not lie within a Groundwater Source Protection Zone. However there are two 'Zone III – Total Catchment' designated areas within 1km of the site boundary.

The Envirocheck report (Landmark, 2008) presents records of two groundwater abstractions within 1km of the site. These abstractions are used for industrial, commercial and public services. A further five abstractions have been identified at distances between 1km and 2km of the site. Two surface water abstractions have been identified within 1km of the site associated with refuse and recycling and industrial processes. A further two surface water abstractions were identified between 1km and 2km from the site boundary.

2.5 Hydrology and Drainage

The nearest surface watercourse is the northerly flowing River Medway, which forms the northern boundary of the site.

2.6 Flooding

The site is designated by the EA as being in a zone susceptible to 'flooding, and 'extreme flooding' (as defined by the Agency) from rivers or sea without defences.

A separate flood risk assessment has been prepared by Mott MacDonald and reference should be made to this document for information on flood risk.

2.7 Radon

The Health Protection Agency has reported that less than 1% of homes within the site area are above the Action Level associated with naturally occurring radon gas. The British Geological Survey advises that no radon protection measures are necessary for new dwellings or extensions.

2.8 Geological and Mining Hazards

The Envirocheck Report indicates that the site is located in an area not affected by coal mining and that the potential shallow mining hazard category is 'no hazard'.

The risk from compressible ground stability hazards and shrinking or swelling clays ground stability hazards is classified as low to moderate.

3. Historical Land Use

3.1 Historical Map Review

Historical Ordnance Survey maps covering the site have been reviewed. Significant details depicted on the maps are identified in the following table. It is noted that each map presents information applicable at the time of the survey and is subject to surveying and cartographic errors and/or advances. Revisions to maps are made at irregular intervals and it is possible that some development may have taken place within the area under consideration that have not been revealed by the maps.

Table 3.1: Evidence of Historical Land Use

Map Year of First Occurrence (Scale)	Significant Land Use on the Site	Significant Land Use in the Vicinity of the Site
1866 (1:2,500)	The side of the site is partly mud flats and partly wharf buildings, plus a coal yard and possibly some residential buildings in the eastern part of the site. A sluice gate and outfall are present in the northern part of the site.	A brewery is situated 50m to the southwest.
1898 (1: 2,500)	As above.	Immediately to the west of the site has been developed with several large buildings (possibly warehouses) with a wharfside crane instead of the platforms. Saw mills and timber yards are situated adjacent to one another to the south of the site. A steam saw mill was constructed to the southwest.
1909 (1:2,500)	Three small tanks now present adjacent to wharves.	As above although the brewery is no longer present.
1932 (1:2,500)	As above	A tramway was present to the east of the site.
1954 (1:1,250)	The building layout remains largely unchanged but the buildings are now marked as a Cold Store, Ice Factory and warehouses plus an electricity substation, a crane, a pier and two Public Houses.	Adjacent to the west of the site are industrial buildings with a chimney, plus timber sheds. The tramway is no longer marked.
1958 – 1970 (1:1,250)	The area of land which has been reclaimed has increased and the site now consists of offices in the northern part of the site, with the exception of the sluice and outfall in the very northern part which remain. The southern part remains largely unchanged.	As above plus a Coal Depot is present to the west of the site.
1967 – 1970 (1:2,500)	As above.	As above.
1970 – 1978 (1:1,250)	As above although the area of the sluice and outfall appear to have been reclaimed. Two of the large warehouses, the factory and one of the Public Houses are no longer present.	As above.
1977 – 1989 (1:1,250)	The warehouse in the northern part of the site is no longer marked.	Rats Bay Pumping Station is now marked.
1994 (1:1,250)	The remaining warehouse has now been removed. The properties in the southeastern part of the site remain unchanged.	The Coal Depot is no longer marked.

3.2 Summary of Site History and Potential Contamination Sources

The site has been developed with a variety of industrial/ commercial uses both on-site and in the vicinity, with evidence of some residential use towards the southeastern end of the site.

The principal contamination sources highlighted by the historical map review within the proposed development area relate to the existing site usage as car parking (and any potential fuel/ oil spillages/ losses) and historical uses for wharves (including the crane and tanks), warehouses, an ice factory and the electricity substation. In addition historical off-site uses of the Coal Yard, Timber Yards and Saw Mills could be potentially contaminative.

The historical maps are also of geotechnical significance. The 1866 map shows that in the general area of the site (Sun Pier to the western boundary of the site) an older river wall was present but was further back than the current one. On the site itself, this old wall continued across the centre of these areas, meaning that about half of the areas were occupied by the river front and mudflats, whilst the other half was occupied by a number of small wharf buildings and a coal yard. The area currently occupied by the Rats Bay Pumping Station was mudflats as the river wall was much further back than at present. The river front was also marked by a number of small jetties. By 1898 the area between Sun Pier and approximately 25m into the development area from the western boundary had been extended out into the Medway to approximately the current wall position. Wharves and jetties still occupied the remaining part of the site. This arrangement persisted but by 1958, the site river boundary had been extended to approximately the current position, with the exception of the Rats Bay Pumping Station area which was not reclaimed until the 1970s.

It is thus likely that the remnants of these former structures, including the old river walls, underlie the site.

4. Other Environmental Records

The following details were obtained from the Envirocheck Report. Significant records identified in Table 4.1.are discussed in further detail in Sections 4.1 to 4.3.

Table 4.1: Other Environmental Records

Record / Source of Information	On Site	0m to 250m	251m to 500m	501m to 1000m
Contaminated Land Register Entries and Notices				
Discharge Consents		19	7	17
Enforcement and Prohibition Notices				
Integrated Pollution Controls				
Integrated Pollution Prevention and Controls		2	2	4
Local Authority Integrated Pollution Prevention Controls				
Nearest Surface Water Feature		Yes		
Pollution Incidents to Controlled Waters	1	6	3	12
Prosecutions relating to Authorised Processes				
Registered Radioactive Substances				
River Quality				
Licensed Waste Management Facilities				2
Registered Landfill Sites				
Registered Waste Transfer, Treatment or Disposal Sites				1
Historical Landfill Sites			1	3
Control Of Major Accident Hazards (COMAH) sites				1
Notifications of Installations Handling Hazardous Substances				1
Contemporary Trade Directory Entries		26	38	145
Fuel Station Entries			1	3
Sensitive Land Uses				

4.1 Waste Activities

There are records of five historic landfill sites within a 1km radius of the site, the closest site being 317m northwest and used for inert waste. In addition, there are records of three Waste Management Facilities, two Waste Transfer Sites and one Waste Treatment and Disposal site within a 1km radius of the site.

4.2 Pollution Incidents to Controlled Waters

There are records of a number of pollution incidents to controlled waters within the vicinity of the site. One is recorded as on-site and relates to oils on the Medway in January 1993 although it is only registered as a Category 3 – Minor incident. All other pollution incidents recorded within 500m of the site were registered as Category 3 – Minor incidents and relate to oils, sewage, urban run-off or firefighting foam/ runoff.

4.3 Fuel Station Entries

Two active fuel stations are recorded within 1km of the site. The nearest is located approximately 350m to the south of the site with the second approximately 500m to the north of the site on the opposite side of the Medway.

5. Previous Ground Investigations

The approximate locations of the previous Ground Investigations are presented in drawing 251348/EES/EVT/01/A in Appendix B.

5.1 Mott MacDonald 2009 (Holborn Wharf Development – on-site)

Mott MacDonald designed and managed a ground investigation in the western part of the site only (as the other areas were not accessible) to determine the strata underlying the site, to provide data regarding the geotechnical properties of these strata, to investigate soil and groundwater contamination conditions beneath the site and to provide data on the presence, prevalence and pressures of ground gases. The scale and scope of the investigation was designed to be consistent with an 'Exploratory Investigation' as defined in BS10175:2001. The locations of the exploratory holes and trial pits undertaken during the investigation are presented on Drawing no. 251348/EVT/03/001. There are significant differences between this final layout and the planned layout for the investigation. This resulted from the large number of ground obstructions that were encountered during the investigation.

The investigation of the site was carried out by Fugro Engineering Services Ltd (FES, 2009). The site works were carried out between 26 January and 10 February 2009. Groundwater monitoring and ground gas monitoring was undertaken following the fieldwork. The ground gas monitoring was delayed due to the need to obtain monitoring results on at least two occasions when atmospheric pressure was low and falling, in accordance with current guidance. In the event, the last gas monitoring visit was undertaken on 27 April 2009.

The intrusive works are summarised in Table 5.1.

Table 5.1: Summary of FES Ground Investigation 2009.

Exploratory location	Investigation method	Depth reached (m bgl)	Monitoring installation	Comments
BH1R	Rotary	30.0	19mm Piezometer (Chalk)	-
BH2R	Rotary	3.6	50mm Standpipe (made ground)	-
BH2AR	Rotary	50.7	19mm Piezometer (Chalk)	-
BH7C	Cable percussive	20.0	50mm Standpipe (Chalk)	-
BH8C	Cable percussive	16.0	75mm plastic liners (made ground, alluvium and chalk)	-
BH9C	Cable percussive	15.0	50mm Standpipe (made ground and alluvium)	-
BH11C	Cable percussive	4.2	-	-
BH12C	Cable percussive	16.0	50mm Standpipe (made ground and alluvium)	-
WS3D	Dynamic probe (window sampler)	5.0	-	Three other DP holes were aborted due to buried services or obstructions
TT1	Mechanical excavator	3.2	-	Undertaken to investigate specific construction details of the existing river wall that forms the northern boundary of the site
TT2		0.2	-	

The following sequence of strata was identified in this ground investigation:

Table 5.2: Summary of Strata Encountered

Strata	Typical Descriptions	Depth (m) to Base Below Current Ground Level	Thickness (m)
Made Ground (with Alluvium mixed into lower layers)	Very variable, but includes the following descriptions: Tarmacadam and/or concrete at surface, underlain with ashy sand in BH7C, brick layer within TT1; Soft silt and clay with chalk and brick fragments; Very soft to soft gravelly clay and clayey silt, gravel is flint, chalk, brick and clinker; Chalk fill with angular and subangular chalk fragments, flint fragments, furnace slag and ash; and Occasional pockets of organic clay.	4.2 – 6.9	4.2 – 6.9
River Terrace Deposits	Medium dense to dense sandy gravel with some cobbles. Gravel is flint and Chalk.	6.7 – 10.8	1.4 – 3.9
Upper Chalk	Clasts of weak medium to high density white chalk with some staining and occasional sand lenses; or Structureless Chalk composed of chalk gravel and chalk in matrix of sandy silt; or Extremely weak to weak medium dense chalk, fractures are closely spaced and randomly orientated.	Base not proven	Base not proven

The wall forming the bank of the River Medway, on the northern boundary of the site is of critical importance to the development as it is intended to be retained to form the river wall of the completed development. However, prior to this investigation, very little information was available about the geometry of the wall, its depth, thickness and the presence or otherwise of tie bars supporting it. Therefore, at the time of the ground investigation, the following additional investigation activities were undertaken to determine the following matters with respect to the sheet pile wall:

- Depth of the wall by a geophysical (parallel seismic) investigation
- Thickness of the wall by ultrasonic investigation
- Presence of tie bars or anchorages at the back of the wall by excavating trial trenches.

Ground gas monitoring was undertaken on four occasions (11 March, 18 March, 25 March and 27 April 2009). On all visits the Gas Screening Value (GSV) was effectively zero and therefore the site is classified as falling into Characteristic Situation 1, CS1 (CIRIA, 2007) with the exception of one measurement on the second monitoring in BH1R. The methane concentration measured was 1.2% along with a flow rate of 0.2l/hr giving a Gas Screening Value of 0.24l/hr. This suggests that that this area of the site might be classified as falling into Characteristic Situation 2, CS2. During drilling this borehole between 2.0m and 4.5m depth was noted by the driller to be apparently contaminated. Although the tip of this installation is screened at a lower level, it is probable that the presence of slightly elevated concentrations of methane is associated with this area of contamination, and certainly with the made ground. This is because the groundwater level in all strata is above the base of the made ground.

Very limited soils contamination was encountered at the site. None of the measured concentrations of inorganic contaminants were above the applicable screening values. Light end aliphatic and aromatic TPH was slightly elevated above the applicable SGV/SSV in one sample of made ground at BH1R. PAH compounds were slightly elevated above the applicable SSVs in one sample of made ground in BH2AR.

No significant groundwater contamination was identified during monitoring. Based upon observed groundwater contaminant concentrations, the soils contamination does not appear to be leaching into the underlying groundwater bodies.

This investigation and generic quantitative risk assessment concluded that risks from contaminated soils and groundwater on the site to groundwater and surface waters, including the River Medway, were considered 'LOW'. Risks to human health, including construction workers, future site operatives and maintenance workers from contaminated soils and groundwater on the site were also considered 'LOW'. In addition, the risks to human health from ground gases were considered to be 'LOW'.

5.2 Mott MacDonald 2010 (The Brook – off-site)

Mott MacDonald also designed and managed a ground investigation as part of the proposed improvement works to the road network along The Brook, located to the east of the development site, in December 2009. This area is not located adjacent to the development site and therefore only a limited summary of the findings is presented in this report.

The ground investigation was carried out by Geotechnics Ltd, and comprised the following:-

- 3 No. cable percussion boreholes (BHTB03, BHTB04 and BHGL01) excavated to 15m depth.
- 5 No. dynamic sample boreholes (BHTB01, 02, 05, 06 and 07) excavated to a maximum of 5m depth.
- 5 No. trial pits (BHTB02, TPTB01, 02, 03 and 05) excavated to between 0.5m and 2.75m depth.

The location of the exploratory holes is presented in Drawing number 219596/GGI/IN88/01 in Appendix B.

The ground conditions encountered can be summarised as follows (Mott MacDonald, 2010a):

- Made ground to depths of 0.6m to at least 3.0m which was highly variable along the alignment of The Brook in terms of both depth and composition. The material was predominantly granular, comprising fragments of red brick, chalk and flint.
- Alluvium of thickness ranging from 0.6m to at least 2.45m consisting of compressible silts and clays with varying quantities of gravel materials.
- Head deposits at four of the locations ranging from 0.18m to 2.50m composed of fine to coarse sand and fine to coarse gravel of chalk and flint
- Chalk to at least 15.00mbgl. The Chalk was generally recovered as gravel; containing clasts of Chalk in a matrix of sand and silt. The Chalk was found to contain flint, recovered as occasional gravel and subangular cobbles.

Elevated levels of lead and an isolated level of benzo(a)pyrene were identified in Made Ground. However, in general, contaminant levels identified within site soils were low and risks to human health and water resource receptors were considered to be limited. Negligible/low levels of methane and carbon dioxide were recorded, which together with negligible flow rates, have resulted in a 'Characteristic Situation 1' (very low risk) in relation to ground gas risks.

5.3 Mott MacDonald 2010 (Dynamic Bus Facility – off-site)

Mott MacDonald designed and managed a further ground investigation at the proposed Dynamic Bus Facility (DBF) to the east of the Chatham Waterfront development site in January 2010. The purpose of the investigation was to enable the ground and groundwater conditions at the DBF site to be confirmed and to provide a broad understanding of the extent of and types of contamination present across the site. The investigation findings will be utilised for designing the DBF and the re-aligned Globe Lane and assessing the risks associated with contamination at this site in order to discharge planning conditions.

The ground investigation was carried out by Norwest Holst Soil Engineering Ltd, and comprised the following:-

- 3 No. cable percussion boreholes (BHDBF01A, BHDBF04 and BHDBF05) excavated to 15m depth, positioned at the location of the proposed information centre and perimeter platforms of the bus facility.
- 2 No. cable percussion boreholes with rotary follow on (BHDBF02 and BHDBF03) excavated to a maximum depth of 23m, positioned at the location of the proposed central platforms for the bus facility.
- 7 No. trial pits (TPDBF01A, 01, 02, 03, 04, 05 and 05A) excavated to depths of between 0.25m and 1.53m and positioned along the proposed re-aligned Globe Lane for the purposes of in situ CBR testing.
- 2 No. trial pits (TPDBF07 and TBDBF08) excavated to a depths of 2.0m and 1.73m respectively around the Whitehouse Building to establish the nature of the building foundations and identify underlying obstructions for a proposed services trench along the southern edge of the building.
- 1 No. trial pit (TPDBF09) excavated to 1.9m depth purely for the purposes of archaeological investigation.

The positions of all the exploratory holes are highlighted in the location plan (Drawing number 219596/GGI/IN87/01) shown in Appendix B. It should be noted that borehole BHDBF01 was abandoned due to a concrete obstruction in the inspection pit at a depth of 1.12m. Similarly, trial pit TPDBF01 was abandoned at a depth of 0.25m after encountering a concrete slab beneath the topsoil. Trial pit TPDBF05 was abandoned due to a small brick culvert at a depth of approximately 0.6m. These pits were either repositioned or extended in order to progress them to the target depth.

Soil and leachate chemical testing was undertaken along with groundwater and gas monitoring.

The following sequence of strata was identified by the ground investigation (Mott MacDonald, 2010b):

Table 5.3: Summary of Strata Encountered

Strata	Typical Descriptions	Thickness (m)
Made Ground	Ground surface: asphalt covered car park, turf and topsoil and paved footways. Made Ground: variable in terms of composition, comprising layers of both granular and cohesive material. Upper layers typically composed of gravelly clay with fragments of red brick, flint and chalk. Majority of locations encountered a layer of compacted chalk fill of varying thickness.	3.0 - 3.4
Alluvium	Very soft grey silty clay with bands of peat up to 0.9m in thickness.	2.7 – 4.5
Head Deposits	Loose to very dense fine to coarse sand and fine to coarse gravel of flint and chalk. Occasional pockets of cohesive material and cobbles of flint also encountered.	2.2 – 6.3
Upper Chalk	Chalk was generally recovered as gravel, containing clasts of intact Chalk in a silt matrix. Chalk contained bands of flint, recovered as gravel and occasional sub-angular cobbles.; or Recovery was variable and generally comprised gravel and cobbles of chalk in a silt matrix with gravel of black flint.	Base not proven

Low levels of methane and carbon dioxide were recorded, which together with negligible flow rates, have resulted in a ‘Characteristic Situation 1’ (very low risk) in relation to ground gas risks.

The risk assessment in this report concluded that the principal human health risks relate to construction and maintenance workers who are more likely to come into contact with elevated levels of lead identified in the made ground. It is believed that these relate to the historic use of the general area as a main road and the subsequent historic inputs of lead-bearing particulates to air and soils from leaded petrol.

The main risks to groundwaters within the underlying Principal Aquifer and the nearby River Medway relate to slightly elevated leachable levels of copper, chromium, selenium and iron exceeding assessment criteria. The slightly elevated levels of iron and selenium identified in groundwaters were not seen in the corresponding soil leachate samples and can therefore be assumed to have an off-site source. The iron is likely to be natural and relate to the high iron content of the underlying superficial deposits. Slightly elevated levels of copper and chromium seen in leachates were also found to be present in groundwaters, although at higher concentrations, suggesting that although site soils may be contributing to some of the levels observed, it is likely that there are also additional off-site sources for these contaminants. Using details of local tide times, groundwater chemical indicators of saline influences and groundwater levels, it would appear that at high tide the levels of chromium, copper and selenium are more elevated than at mid/low tide with iron levels showing the opposite pattern. This suggests that the elevated levels of chromium, copper and selenium are likely to be indicative of the quality of the River Medway in general. Contaminant threshold values were exceeded in relation to risks to the integrity of water supply pipes.

A number of recommendations for mitigation activities were proposed in this report mainly relating to use of PPE by construction workers and appropriate re-use of impacted soils.

6. Conceptual Model and Hazard Assessment

The primary regulatory regime under which contaminated land is managed in the UK is Part IIA of the Environmental Protection Act (EPA), 1990. The strategy for the assessment of potential land contamination adopted in this report is based on current guidance documents related to Part IIA of the EPA, with particular reference to CIRIA Report C552.

A key element of the Preliminary (Phase 1) Risk Assessment is the development of a conceptual model which may be refined or revised as more information and understanding is obtained through the risk assessment process. The conceptual model is described in terms of the contaminant Sources, transport Pathways and possible Receptors that may be present, and the potential 'Pollutant Linkages' between them, as defined in the relevant legislation and guidance. These activities are described in CIRIA C552 as "hazard identification".

6.1 Development of Conceptual Model – Hazard Identification

6.1.1 Sources of Contamination

6.1.1.1 On site

S1: The site is currently used as a car park and limited commercial/ retail use. Potential hydrocarbon and oil contamination may be present as a result.

S2: Historical land use included industrial buildings, wharves and warehouses which may have contained potentially contaminative materials and processes.

S3: Sources associated with construction activities for proposed mixed use development, for example potential fuel spillages.

S4: Sources associated with future use of proposed development for residential/commercial purposes. Since the proposed end use is residential and commercial, it is considered that this is not a significant potential source, and is thus not considered further.

6.1.1.2 Off Site

S5: Historically, a number of potentially contaminative land uses have been present in the vicinity of the site including coal yards and depot, saw mills, timber yards and a Pumping Station.

6.2 Potential Contamination Transport Pathways

P1: Horizontal and vertical migration of contaminants within groundwater. Groundwater is present within the River Terrace/Head Deposit Gravels and Chalk which are likely to be mostly relatively high permeability strata. Groundwater is anticipated to flow north towards the River Medway. However, due to the proximity to the river, it is likely that the groundwater beneath the site is subject to tidal influences.

P2: Direct contact (including ingestion and dermal contact) with contaminated soils.

P3: Airborne pathways. Inhalation or contact with potentially contaminated dust or vapours. Dust is unlikely to be an issue for future site users. However, this is a potential pathway where noxious vapours or explosive ground gases could accumulate in enclosed structures.

P4: Vertical migration of groundwater and/or ground gas along preferential pathways created by potential piled foundations beneath the new development.

6.3 Potential Human and Environmental Receptors

6.3.1 Environmental Receptors

R1: Groundwater. The Superficial Deposits (Secondary) and Upper Chalk (Principal) aquifers are potential receptors.

R2: Surface Water. The River Medway is also a potential receptor as it is expected that the shallow aquifer is in hydraulic continuity with the river which is considered to be hydraulically down gradient of the site.

6.3.2 Human Receptors

R3: Current site users.

R4: Workers involved in the development of the site would be potential receptors, although this is considered to relate only to acute exposure.

R5: Future end users (residents, site commercial workers, maintenance workers and visitors). At the present time, the designs for the development do not include any residential gardens.

6.4 Conceptual Model

Based upon the potentially active Sources, Pathways and Receptors defined in the previous sections, a conceptual model can be derived, including the potential pollutant linkages presented in Table 6.1 below.

A schematic representation of this conceptual model is presented in drawing 251348/EES/EVT/02/A in Appendix B.

Table 6.1: Summary of site conceptual model

Potential Sources	Potential Pathways	Potential Receptors
S1: Current site use as a car park and commercial/ retail	P1: Horizontal and vertical migration in groundwater	R1: Groundwater in underlying Aquifers
		R2: River Medway
	P2: Direct Contact	R3: Current site users
		R4: Construction workers
	P3: Inhalation of dust and vapours.	R3: Current site users
		R4: Construction workers
		R5: Future site users
S2: Historic on-site land uses	P1: Horizontal and vertical migration in groundwater	R1: Groundwater in underlying Aquifers
		R2: River Medway
	P2: Direct Contact	R3: Current site users
		R4: Construction workers
	P3: Inhalation of dust and vapours.	R3: Current site users
		R4: Construction workers
		R5: Future site users

S3: Construction of proposed development	P1: Horizontal and vertical migration in groundwater	R1: Groundwater in underlying Aquifers
		R2: River Medway
	P2: Direct Contact	R4: Construction workers
	P3: Inhalation of dust and vapours.	R4: Construction workers
	P4: Migration of groundwater and gas along piles	R1: Groundwater in underlying Aquifers
S4: Use of proposed development	These potential linkages not considered further as source is considered not to be significant.	
S5: Off-site land uses	P1: Horizontal and vertical migration in groundwater	R4: Construction workers

7. Phase 1 Contaminated Land Risk Assessment

7.1 Risk Estimation & Risk Evaluation

The term risk is widely used in different contexts and circumstances, often with differing definitions. In UK Government publications about the environment, the standard definition is that “Risk is a combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence” (CLR11).

Following the development of the conceptual model and the identification and assessment of potential pollutant linkages, a preliminary attempt can be made at the further steps of risk estimation and risk evaluation, as discussed in CLR11 and CIRIA C552, to determine whether an unacceptable contamination risk is likely to exist.

CLR11 defines risk estimation as predicting the magnitude (or consequence) and probability of the risk occurring that may arise as a result of that hazard. This is also identified in CIRIA C552 in which the risk assessment methodology uses qualitative descriptors of consequence, probability and thus risk. These descriptors are adopted for the purposes of this risk assessment. A full description of the risk assessment methodology adopted is given in Appendix CAppendix C, but a brief summary is presented below.

The "hazard" or consequence of a risk occurring is classified into the following categories as defined in Appendix C:

- Severe
- Medium
- Mild
- Minor

The probability or "likelihood" of a risk occurring is classified into the following categories, also defined in Appendix C:

- High Likelihood
- Likely
- Low Likelihood
- Unlikely

For each potential pollutant linkage identified in the conceptual model, the potential risk can be evaluated qualitatively, based on the following principle:

Overall contamination risk = Probability of event occurring x Consequence of event occurring

This relationship can be represented graphically as a matrix (Table 7.1), which is adapted from the CIRIA guidance.

Table 7.1: Preliminary Contamination Risk Assessment Matrix

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High likelihood**	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate risk	Low risk
	Low likelihood	Moderate risk	Moderate risk	Low risk	Very low risk
	Unlikely	Low risk	Low risk	Very low risk	Very low risk

The following preliminary qualitative risk evaluation can therefore be made for each significant pollutant linkage at this site, based upon the defined conceptual model and the risk estimation process discussed above.

Table 7.2: Preliminary Risk Evaluation

Potential Sources	Potential Pathways	Potential Receptors	Consequence	Probability	Risk Category	Comments
S1: Current site use as a car park and commercial/ retail	P1: Horizontal and vertical migration in groundwater	R1: Groundwater in underlying Aquifers	Medium	Unlikely	Low	Data from previous GI indicates low concentrations of contaminants only and therefore probability is considered to be unlikely
		R2: River Medway	Medium	Unlikely	Low	
	P2: Direct Contact	R3: Current site users	Medium	Unlikely	Low	
		R4: Construction workers	Minor	Unlikely	Very Low	Assumes the potential risks can be easily mitigated by the use of correct PPE and the use of welfare facilities
	P3: Inhalation of dust and vapours.	R3: Current site users	Medium	Unlikely	Low	Data from previous GI indicates low concentrations of contaminants in soils (dust) and low levels of ground gas only and therefore probability is considered to be unlikely
		R4: Construction workers	Medium	Unlikely	Low	
		R5: Future site users	Medium	Unlikely	Low	
S2: Historic on-site land uses	P1: Horizontal and vertical migration in groundwater	R1: Groundwater in underlying Aquifers	Medium	Unlikely	Low	Data from previous GI indicates low concentrations of contaminants only and therefore probability is considered to be unlikely
		R2: River Medway	Medium	Unlikely	Low	
	P2: Direct Contact	R3: Current site users	Medium	Unlikely	Low	
		R4: Construction workers	Minor	Unlikely	Very Low	Assumes the potential risks can be easily mitigated by the use of correct PPE and the use of welfare facilities
	P3: Inhalation of dust and vapours.	R3: Current site users	Medium	Unlikely	Low	Data from previous GI indicates low concentrations of contaminants in soils (dust) and low levels of ground gas only and therefore probability is considered to be unlikely
		R4: Construction workers	Medium	Unlikely	Low	
		R5: Future site users	Medium	Unlikely	Low	
S3: Construction of proposed development	P1: Horizontal and vertical migration in groundwater	R1: Groundwater in underlying Aquifers	Severe	Unlikely	Low	Risks can be mitigated by implementation of good environmental practices on site during the works
		R2: River Medway	Severe	Unlikely	Low	
	P2: Direct Contact	R4: Construction workers	Minor	Unlikely	Very Low	Assumes the potential risks can be easily mitigated by the use of correct PPE and the use of welfare facilities
	P3: Inhalation of dust and vapours.	R4: Construction workers	Minor	Unlikely	Very Low	Assumes the risks can be easily mitigated by the use of correct PPE and the use of welfare facilities. Data from previous GI indicates low concentrations of contaminants in soils (dust) and low levels of ground gas only and therefore probability is considered to be unlikely
	P4: Migration of groundwater and gas along piles	R1: Groundwater in underlying Aquifers	Severe	Unlikely	Low	A Foundation Works Risk Assessment will be undertaken prior to construction to identify a Piling method which will mitigate potential risks from this pathway
S5: Off-site land uses.	P1: Horizontal and vertical migration in groundwater	R4: Construction workers	Minor	Unlikely	Very Low	Assumes the potential risks can be easily mitigated by the use of correct PPE and the use of welfare facilities

Notes: It should be noted that this assessment is based upon site investigation data from part of the site only and it cannot be guaranteed that this an accurate reflection of the ground conditions within the whole of the development area.

8. Conclusions and Recommendations

8.1 Conclusions

A Phase I Contaminated Land Risk Assessment has been undertaken in order to identify risks to the project from land contamination, to identify any actions that may be appropriate for the safe development of the site and to support the planning process requirements.

The site is underlain by superficial cover of made ground and alluvium which are underlain by River Terrace / Head Deposits (varying across the site), overlying the Lewes Nodular Chalk Formation (formerly classified as Upper Chalk) part of the White Chalk Subgroup.

The site has been developed with a variety of industrial/ commercial uses both on-site and in the vicinity, consisting mainly of warehousing and wharf buildings associated with the River Medway, but also including a large pumping station adjacent to the site and other uses. There was evidence of some residential use towards the southeastern end of the site. The river wall has historically been further inland than the present alignment, with the present alignment not reached until the 1970s. This suggests that remnants of former structures may remain beneath the development area.

The principal contamination sources within the proposed development area relate to the existing site usage as car parking (and any potential fuel/ oil spillages/ losses) and historical uses for wharves (including the crane and tanks), warehouses, an ice factory and the electricity substation. In addition historical off-site uses of the Coal Yard, Timber Yards and Saw Mills could be potentially contaminative.

Nevertheless, the preliminary risk assessment, using desk study information and previous ground investigation data, concludes that there is a **LOW** risk to water resource receptors (groundwater in the underlying Secondary and Principal aquifers and the River Medway), a **LOW** risk to current and future site users, and a **VERY LOW** risk to construction workers, assuming appropriate PPE is used and good site hygiene practices are followed. No significant remediation works are likely to be necessary in the areas of the site investigated to date.

However, it should be noted that this assessment is based upon site investigation data from part of the Chatham Waterfront site only and it cannot be guaranteed that this an accurate reflection of the ground conditions within the remainder of the development area.

8.2 Recommendations

It is recommended that additional intrusive site investigation and programme of environmental monitoring and laboratory testing is undertaken in the areas of the site that have not previously been investigated to more fully understand the subsurface conditions at the site as a whole and to confirm the findings of the initial ground investigation and conceptualised pollutant linkages highlighted in this report.

The site investigation should assess soil, groundwater and ground gas conditions and composition and the associated reporting should assess any risks to receptors (such as controlled waters, human health, and so on). It is recommended that these investigations are undertaken in conjunction with any Geotechnical Investigations which will be required to support the design process.

9. References

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MOTT MACDONALD (2009) 366 Holborn Wharf Geotechnical and Geo-environmental Interpretative Report (Area A) June 2009, Report Ref: 251348/EVT/03

MOTT MACDONALD (2010a) Medway Consultancy IN88 The Brook, Geo-Environmental Investigation Geotechnical Interpretative Report, February 2010, 219596/FNG/IN88/02/A

MOTT MACDONALD (2010b) Medway Consultancy IN87 Dynamic Bus Facility, Geo-Environmental Investigation Geotechnical Interpretative Report, March 2010, 219596/FNG/IN87/02/A

Water Framework Directive, (2000) European Union

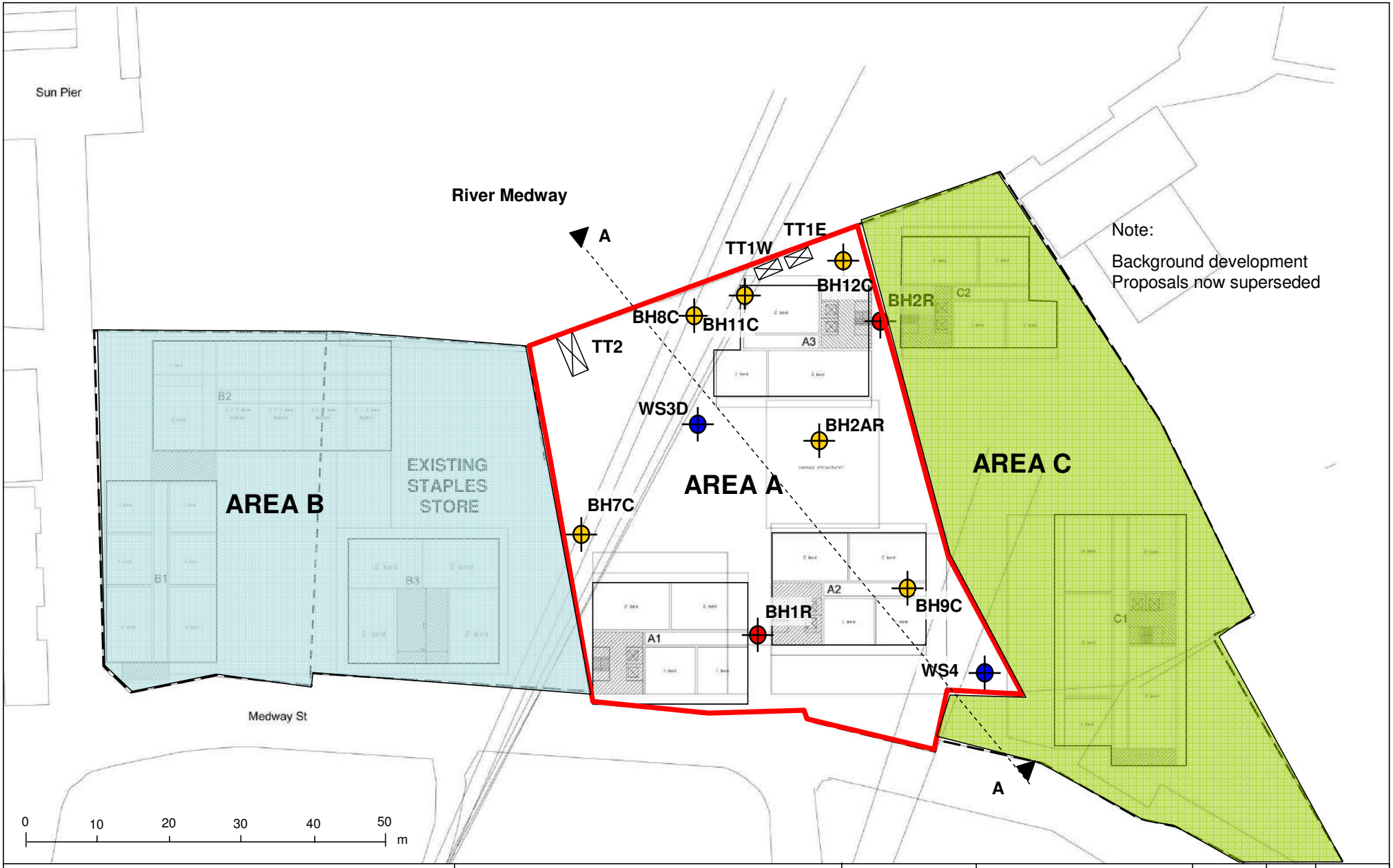
Appendices

Appendix A. Envirocheck Report 23
Appendix B. Drawings and Figures 24
Appendix C. Contamination Risk Assessment Methodology 25

Appendix A. Envirocheck Report

Please see attached cd

Appendix B. Drawings and Figures



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Client
Dominion Housing Group

Project
366 Holborn Wharf, Chatham

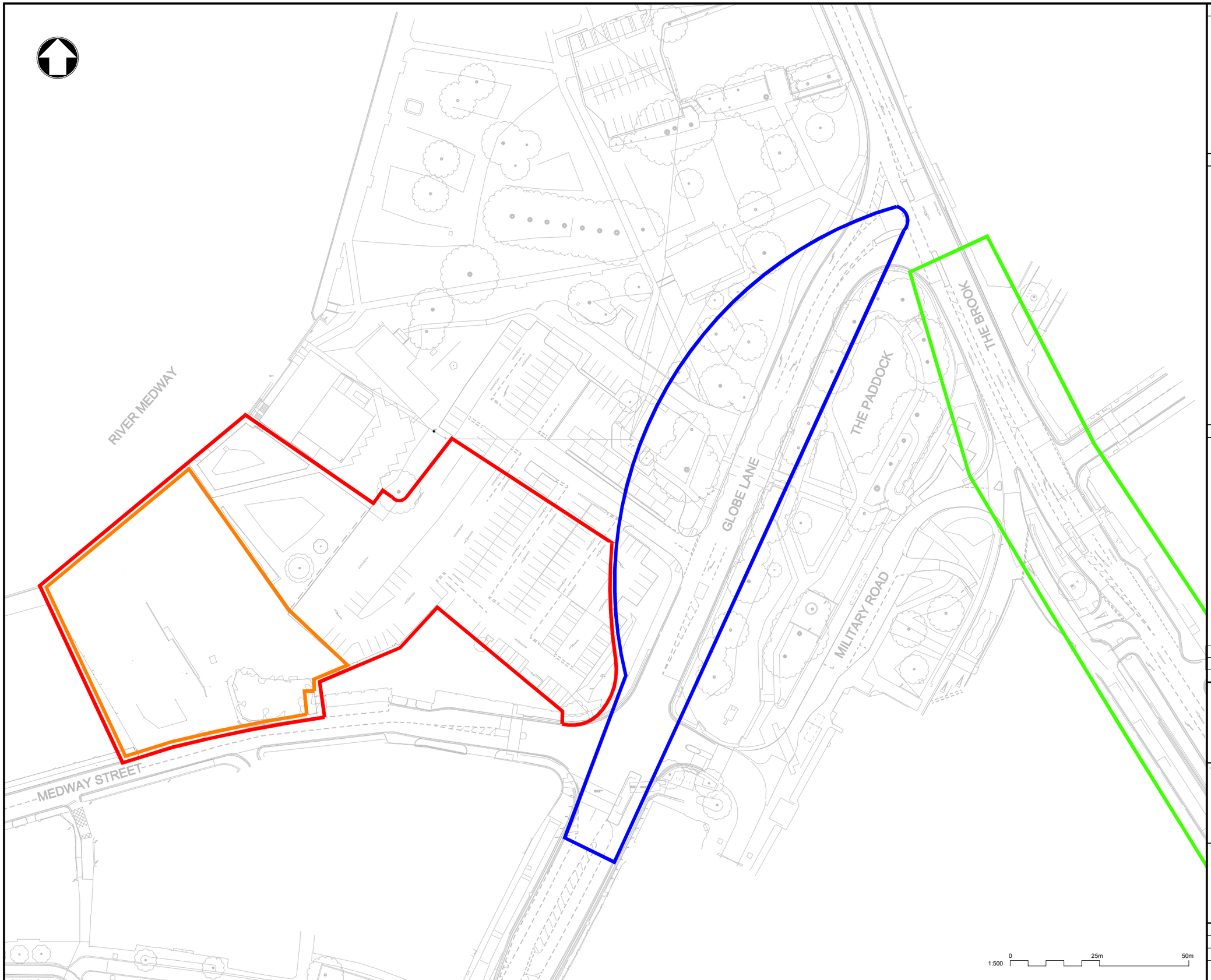
Key

- Rotary Borehole (30-50m deep)
- Cable Percussion Borehole (20m deep)
- Window Sample Borehole (5m deep)
- Trial Trench (3m deep)

N

Drawing No.			
	Drawn	JS	01/06/09
	Checked	TB	01/06/09
251348/EVT/03/001	Approved	TB	01/06/09

Title
Site Layout and Exploratory Hole Locations



1:500 0 25m 50m

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Notes

Key to symbols

- Approximate boundary of development area.
- Approximate area of GI for Dynamic Bus Facility
- Approximate area of GI for 'The Brook' works.
- Approximate area of GI (MM 2009) on-site.

Reference drawings

Rev	Date	Drawn	Description	Ch'k'd	App'd
P2	01/12/10	CJE	Preliminary Issue	LJB	TB
P1	28/10/10	MB	Preliminary Issue	LJB	TB

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Client

a2dominion

Medway Renaissance

Title

Site Layout Plan

Designed	L. J. Bethell		Eng check	-	
Drawn	C. J. Easson		Coordination	-	
Dwg check	L. J. Bethell		Approved	T. Blower	

Scale at A1	Status	Rev
1:500	PRE	P2

Drawing Number

MMD-251348-EVT-DR-00-XX-0001

DRAWING NUMBER 219596/GGI/IN88/01
SHEET 1 OF 1

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4. All dimensions are in millimetres unless shown otherwise.
5. For local UXO threat and possible Alluvium deposits refer to EOD contracts limited 2000 and Landmark Envirocheck 2008 respectively.

Legend:

- New Carriageway Construction
- New Footway Construction
- Existing Carriageway
- Existing Footway
- Bus Lane
- Bus Stop
- Working Area for Retaining Wall and 1:3 Embankment
- Working Area for Retaining Wall and 1:3 Embankment
- Retaining Wall (0.5m wide)
- Borehole
- Borehole - Dynamic Sample
- Trial Pit with Dynamic Sample follow on
- Trial Pit

INDEX	AMENDMENTS	DATE
AB	As Built	26.01.10
P2	Final Issue	23.11.09
P1	Preliminary Issue	19.10.09

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PROJECT

The Brook - IN88
Geo-environmental Ground Investigation

TITLE

Primary Highway Network
The Brook
As Built Ground Investigation
Location Plan

DRAWN	MJH	DATE	October 2009
DESIGNED	CMB		
CHECKED	RV	SCALE @ A1	1:500
APPROVED			

DRAWING NUMBER 219596/GGI/IN88/01 REV AB
SHEET 1 OF 1

1:500 0 25m 50m

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TP DBF 07

TP DBF 08

The Whitehouse

TP DBF 09

BH DBF 05

TP DBF 05

TP DBF 04

BH DBF 03

BH DBF 04

TP DBF 03

BH DBF 02

TP DBF 02

BH DBF 01

BH DBF 01A

TP DBF 01A

TP DBF 01

BUS STOP ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫ ⑬

BUS LANE

Realigned Globe Lane

Globe Lane Car Park Access

The Brook

The Paddock

Military Road

Medway Street

Diag. 1040.2

Diag. 1018.1

Diag. 1003.1

Diag. 1025.1

Dropped kerb crossing

RGdb (LH)

RGdb (RH)

3.0m

5.0

0 1:250 12.5m 25m

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Legend:

- Borehole - cable percussion
- Trial Pit
- Borehole - cable percussion with rotary follow on

INDEX	AMENDMENTS	DATE
P2	Final Issue	10.11.09
P1	First Issue	26.10.09

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PROJECT

The Dynamic Bus Facility - IN87
Geo-environmental Ground Investigation

TITLE

NHSE Ground Investigation Locations

DRAWN	MJH	DATE	January 2010
DESIGNED	CB		
CHECKED	RV	SCALE @ A1	1:250
APPROVED			

DRAWING NUMBER 219596/GGI/IN87/01 REV AB

SHEET 1 OF 1

SOURCES

S1 = Current site use as a car park/ commercial/ retail

S2 = Historic industrial land use

S3 = Construction of proposed development

S4 = End use of mixed used development

S5 = Off-site land uses

PATHWAYS

P1 = Horizontal and vertical migration of contaminants within groundwater

P2 = Direct contact with contaminated soils

P3 = Inhalation or contact with dust/vapours

P4 = Preferential pathways along piles.

RECEPTORS

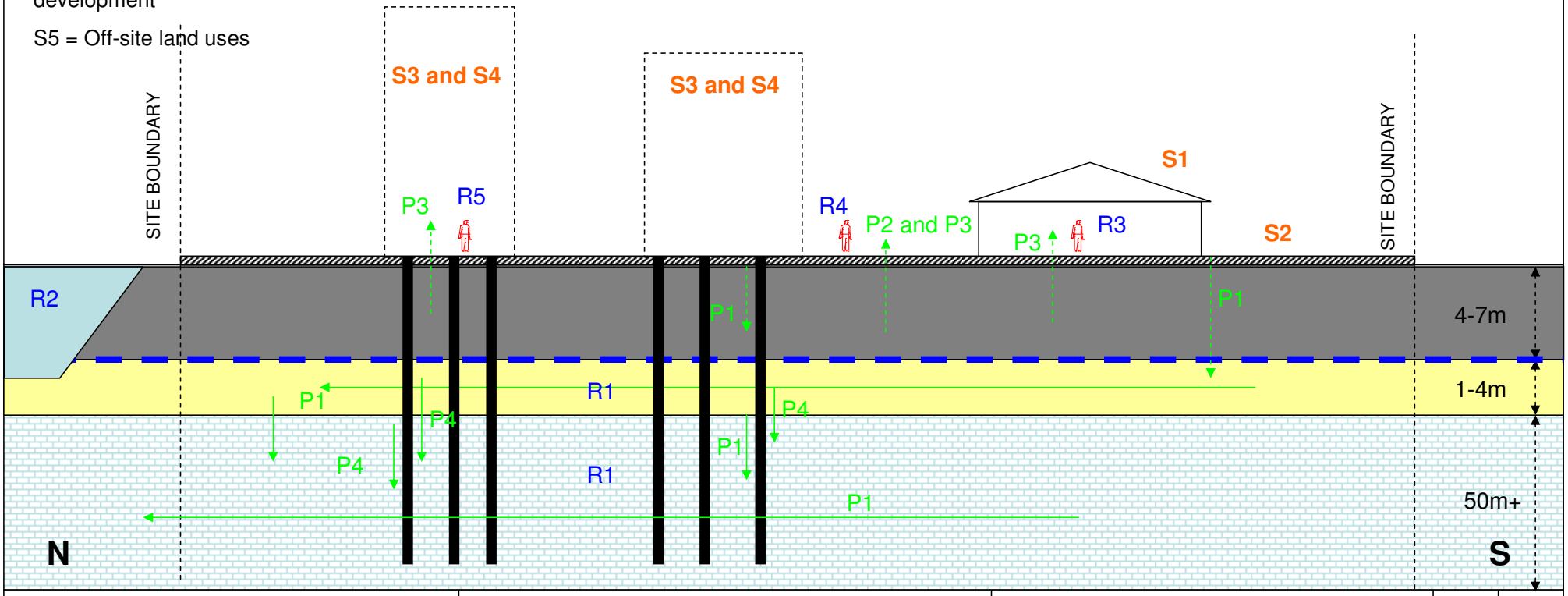
R1 = Groundwater in the underlying aquifers

R2 = River Medway

R3 = Current site users

R4 = Construction workers

R5 = Site end users



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MADE GROUND

GRAVELS

UPPER CHALK

RIVER MEDWAY

POTENTIAL PILES

GROUNDWATER LEVEL

HARDSTANDING

PROPOSED DEVELOPMENT

Title:
Conceptual Site Model Schematic Cross Section

Drawn	JS
Checked	LB
Approved	TB

NOT TO SCALE

Drawing No: 251348/EES/EVT/02/A

Client: Medway Renaissance and A2 Dominion

Appendix C. Contamination Risk Assessment Methodology

The following Contaminated Land Risk Assessment methodology is based on CIRIA C552 (2001) Contaminated Land Risk Assessment – A Guide to Good Practice, in order to quantify potential risk via risk estimation and risk evaluation, which can be adopted at the Phase I stage. This will then determine an overall risk category which can be used to identify likely actions. This methodology uses qualitative descriptors and therefore is a qualitative approach.

The methodology requires the classification of:

- the magnitude of the consequence (severity) of a risk occurring, and
- the magnitude of the probability (likelihood) of a risk occurring.

The potential consequences of contamination risks occurring at this site are classified in accordance with the following table, which is adapted from the CIRIA guidance.

Table **Error! No text of specified style in document.**.1: Classification of Consequence

Classification	Definition of Consequence
Severe	Short-term (acute) risks to human health. Short-term risk of pollution of sensitive water resource or ecosystem. Catastrophic damage to crops/buildings/property/infrastructure, including off-site soils.
Medium	Medium/long-term (chronic) risks to human health. Medium/long-term risk of pollution of sensitive water resource or ecosystem. Significant damage to crops/buildings/property/infrastructure (on or off-site). Contamination of off-site soils.
Mild	Easily preventable, permanent health effects on humans. Pollution of non-sensitive water resources. Localised damage to crops/buildings/property/infrastructure (on or off-site).
Minor	Easily preventable, non-permanent health effects on humans, or no effects. Minor, low-level and localised contamination of on-site soils. Easily repairable damage to crops/buildings/property/infrastructure.

The probability of contamination risks occurring at this site will be classified in accordance with Table Error! **No text of specified style in document..1**, which is also adapted from the CIRIA guidance. Note that for each category, it is assumed that a pollution linkage exists. Where a pollution linkage does not exist, the likelihood is zero, as is the risk.

Table **Error! No text of specified style in document.**.2: Classification of Probability

Classification	Definition of Probability
High Likelihood	Circumstances are such that an event appears very likely in the short-term or almost inevitable in the long-term; or there is already evidence that such an event has occurred.
Likely	Circumstances are such that such an event is not inevitable, but is possible in the short-term and is likely over the long-term.
Low Likelihood	Circumstances are such that it is by no means certain that an event would occur even over a longer period, and it is less likely in the short-term.
Unlikely	Circumstances are such that it is improbable that an event would occur even in the very long-term.

For each possible pollution linkage (source-pathway-receptor) identified, the potential risk can be evaluated, as presented in Section 6. Based upon this, CIRIA C552 presents definitions of the risk categories, together with the investigatory and remedial actions that are likely to be necessary in each case, as in Table Error! **No text of specified style in document..3**. These risk categories apply to each pollutant linkage, not simply to each hazard or receptor.

Table **Error! No text of specified style in document.**.3: Definition of Risk Categories and Likely Actions Required

Risk Category	Definition and likely actions required
Very high	Severe harm to a defined receptor is very likely, or has already occurred. The risk is likely to result in a substantial liability. Urgent investigation (if not already undertaken) is likely to be required. Urgent remediation is likely to be required.
High	Harm to a defined receptor is likely. The risk, if realised, may result in a substantial liability. Urgent investigation (if not already undertaken) is likely to be required. Remediation is likely to be required in the long term, possibly sooner.
Moderate	Harm to a defined receptor is possible, but severe harm is unlikely. Investigation is likely to be required to clarify the level of potential liability and risk. Some remediation may be required in the longer term.
Low	Harm to a defined receptor is possible, but is likely to be mild at worst. Liabilities could theoretically arise, but are unlikely. Further investigation is not required at this stage. Remediation is unlikely to be required.
Very low	Harm to a defined receptor is unlikely, and would be minor at worst. No liabilities are likely to arise. Further investigation is not required at this stage. Remediation is very unlikely to be required.